

# A Framework for Implementation of Integrated Quality System (IQS) in Manufacturing - Based on Survey Finding

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**Abstract-** Implementation of quality and environmental systems and securing certification thereof has become important activities for many manufacturing organizations. There is a widespread phenomenon in that regard around the world. Thus, a need has emerged to integrate these systems in order to reduce wasteful redundancies and generate synergetic effects. The primary concern of this paper is to identify those factors that can construct an Integrated Quality System (IQS). Data has been gathered from responses of two questionnaire surveys. First survey has been conducted in an electronic company which is a subsidiary of a large Japanese company. Second questionnaire survey has been conducted among 34 Malaysia companies. The surveys revealed the implementation level of IQS, primary and secondary factors that constitute an IQS. General conclusions have been drawn from the survey findings. Based on the findings, a conceptual framework of an IQS is developed and presented in this paper. Due to the constraint time, it couldnot be tested adequately. However, it provided enough evidence and can be proposed to manufacturing settings ready to initiate an IQS. The outcome of this work is expected to be powerful basis for future research directions especially as an indicator for the development of a suitable IQS framework for the local organizations.

**Keywords:** Integrated Quality System, Conceptual Framework, Survey finding

## 1. INTRODUCTION

The International Standards Organization (ISO) provides guidance on the implementation and development of management system models, namely for environmental management and quality management. These standards share similar management techniques and principles to achieve customer expectations at minimum total quality cost. In practice, it has been observed that parallel management systems are difficult to execute since each management system demands a lot of documentation, written procedures, checking, control forms and other paper work [1]. Hence, integrated quality system (IQS) has drawn the attention of the practitioners and academics. The term “integrated” refers to the fact that all the elements if a system must work together for the system to function as a whole [2, 3]. An integrated system represents how an organization is structured whereby each function is related to other functions either directly or indirectly towards forming a total system [2, 3]. An integration of

systems, in whatever form, should always lead to a more effective system [4]. For integration of the quality management and environmental systems, it capitalizes on the advantages of both systems and eliminates confusion [5]. Karapetrovic and Willborn [4] believe that IQS helps to overcome some of the problems caused by lack of clarity in the quality vocabulary. “Linking two systems in a way that results in a loss of independence of one or both, means that these systems are integrated.” The integrated systems then form a “system of systems” where the individual systems still retain their identity.

## 2. SIMILARITIES OF ISO 9001 AND ISO 14001

There are several significant similarities between ISO 9001:2000 and ISO 14001:2004. First and foremost, both are international standards for management systems that emphasize on developing and implementing a process. Besides, both standards require a policy statement from management, top management commitment, document control, training, corrective action, management review and internal auditing. Table 1 presents the common and unique requirements between ISO 9001 and ISO 14001.

*Table 1 Common and unique requirements between ISO 9001 and ISO 14001 (Source: [6])*

ISO 14001 (EMS)	ISO 9001 (QMS)
<b>Common requirements (aligned numbers are comparative)</b>	
4.1 Policy	4.4.1 Quality Policy
4.2.3 Objectives and targets	4.1.1 Quality Policy (includes objectives)
4.2.4 Environmental management program	4.2.3 Quality Planning
4.3.1 Structure and responsibilities	4.1.2 Organization
4.3.2 Training, awareness, and competence	4.1.8 Training
4.3.4 EMS documentation	4.2.1 General
4.3.5 Document control	4.5 Document and data control
4.3.6 Operational control	4.2.2 Quality system procedures
	4.6 Purchasing
	4.7 Control customer-supplied product
	4.9 Process control
4.4.1 Monitoring and measurement	4.10 Inspection and testing
4.4.2 Non-conformance and corrective and preventive action	4.13 Control of nonconforming product
4.4.3 Records	4.14 Corrective and preventive action
4.4.4 EMS audit	4.16 Control of quality records
4.5 Management review	4.17 Internal quality audits
	4.1.3 Management review
<b>Unique requirements (Not comparative) regardless of alignment</b>	
4.2.1 Environmental aspects	4.3 Contract review
4.2.2 Legal and other requirements	4.4 Design control
4.3.3 Communication	4.8 Product identification and traceability
4.3.7 Emergency preparedness and response	4.11 Control of inspection, and test equipment
	4.12 Inspection and test status
	4.15 Handling, storage, packaging, and delivery
	4.19 Servicing
	4.20 Statistical techniques

## 3. DIFFERENCES BETWEEN ISO 9001 AND ISO 14001

Although the similarities of ISO 9001 and ISO 14001 are important, but it is equally consequential to recognize the differences in order to avoid the common difficulty [6]. For instance, although both standards have the same management system focus, they greatly differ in their roles and the people they affect – both in their nature and customers/consumers

[7]. Besides that, while quality programs are addressed to the needs of the customers, environmental programs target the concerns of regulators and the public. Besides, a part of environmental management may be regulated by local governmental agencies and this does not apply to quality management system. By comparing duration of effects, the effects of implementing an EMS are over a much longer time period than quality management, which is within a relatively short warranty period of the company's products or services [8].

#### **4. THE REASONS FOR INTEGRATION OF ISO 9001 AND ISO 14001**

Combining the QMS and EMS has meant that “... *while the two systems can be seen as individual islands of management activity... duplication is removed and a much more efficient and comprehensive management tool results. The net effect to the company is a far more effective process for managing its business*” [9]. Wright [10] believes that integrating quality and environment systems has simplified their management of the business, but IQS also helps other improvement activity. Besides that, both ISO 9001 and ISO 14001 are management systems which require organizations to formulate policies, to define roles and responsibilities, to appoint management representatives, and to train personnel. With similar management principles, both ISO 9001 and ISO 14001 are helpful for organizations to establish an effective documentation system by implementing a complete series of standards [11]. On the other hand, the models for continual improvement are similar for both the QMS and the EMS. A continual improvement is achieved by the cycle of P-D-C-A (planning-do-check-action) in quality improvement [12].

An IQS can reduce duplication of policies, procedures and records, resulting in reduced effort for system implementation and maintenance. Thus, there is better utilization of resources such as employee skills and time and. Gilbert [13] believes that companies should integrate ISO 14001 audit procedures with other management systems to avoid the duplication of effort because of reduction in the number of internal and external audits. Thus, the costs are reduced as the audit team has to travel to the company only once a year. Zutshi and Sohal [14] believe that an IQS training program for employees saves both time and money and it can avoid confusion that may result from conflicting messages that may be conveyed through separate training programmes. Better utilization of resources and effective training leads to more effective communication across the organization. Furthermore, employees benefit from learning new skills and exchange of ideas and across different departments. Wilkinson and Dale [15] believe that IQS has simplified the management of their business. It is seen as a constantly evolving system that provides direction and structure for the business as well as ensuring the individual certification standards are met in a cost-effective manner.

#### **5. CONCEPTUAL FRAMEWORK OF IQS**

Figure 1 shows the practical steps in developing an IQS. The detailed explanation for each stage will be discussed in the following section. This can definitely be used as a proposed framework for initiating and implementing an IQS.

#### **6. DATA COLLECTION AND ANALYSIS**

Data was collected from two questionnaire surveys. First survey was conducted in an electronic company. Second survey covered 200 companies chosen from several sectors and produced a response rate of 17 percent. The data collected was then analyzed by statistical software SPSS 15.0 and LISREL 8.80.

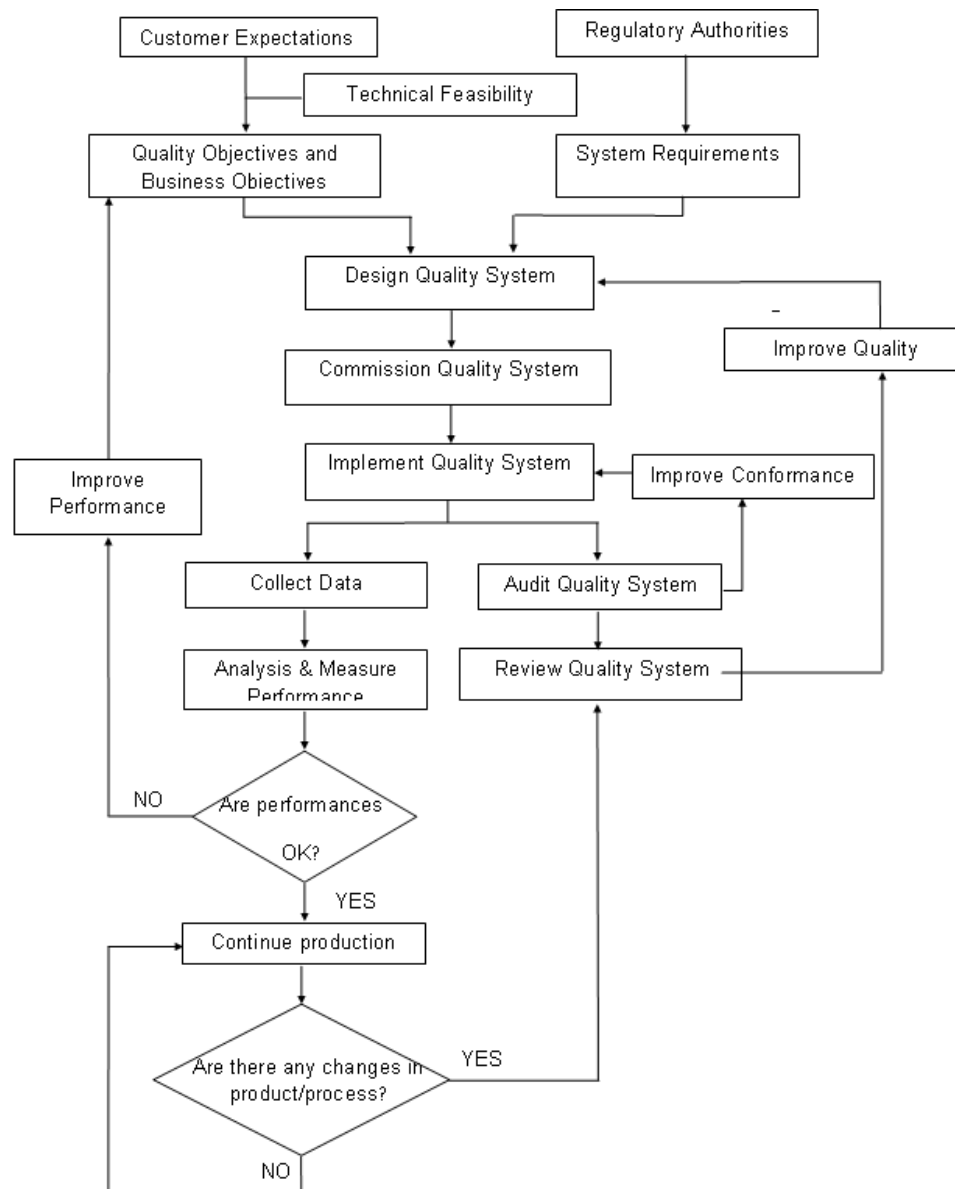


Figure 1 Conceptual Framework of IQS

## 7. FINDINGS OF QUESTIONNAIRE SURVEY - SET A

To determine the relative rankings of the identified factors that may affect the IQS implementation, the relative importance index (RII) was employed [11]. The respondents were asked to rank the listed factors based on their relative importance using a *Likert* scale where the scores are ranging from 1 to 5 where '1' represents the least important and '5' stands for the most important. The scores were then transformed to relative importance index (RII) using Eq. (1).

$$\text{Relative importance index} = \frac{\sum w}{AN} \quad (1)$$

where  $w$  is the score given to a factor by a respondent, ranging from 1 to 5;  $A$  is the highest score (i.e. 5 in the study) and  $N$  is the total number of the respondents.

#### *Major problems for parallel management systems*

This question aimed to gain an understanding of the major problems arising when multiple management systems are used in parallel. Among the problems identified, “Duplication of procedures” was ranked first with Relative Importance Index (RII) value of 0.636. By dealing the management systems separately, the company had to do the same tasks twice for each management systems. This is because both ISO 9001 and ISO 14001 are management systems which require organizations to formulate policies, to define roles and responsibilities, to appoint representatives, and to train personnel. “Increase paper work” as shown in Table 2 was ranked second with an RII value 0.632. Paper work creates problems to the company as each element of the systems is supported by procedure documents, work instruction, and quality records, two separate management system required great volume of paperwork. “Increase management costs” was ranked third with an RII value 0.604 and “Cause complexity of internal management” was ranked fourth with an RII value 0.592. When parallel systems are implemented, companies must appoint management representatives, formulate procedures, and train employees separately. Thus, workload for management team would be doubled. “Low management efficiency” was ranked fifth with an RII value 0.576. By managing ISO 9001 and ISO 14001 separately, management efficiency of the company would be decreased. Although both systems are characterized by same elements, it is difficult to manage the systems independently. “Waste human resources” was ranked sixth with an RII value 0.572 and “Reduce operational performance” was ranked seventh with an RII value 0.564. By implementing parallel management systems, auditing have to be conducted separately and it would certainly cause waste of resources and time.

*Table 2 Problems with parallel management systems*

Problems	Relative Importance Index	Ranking
Duplication of procedures	0.636	1
Increase paper work	0.632	2
Increase management costs	0.604	3
Cause complexity of internal management	0.592	4
Low management efficiency	0.576	5
Waste human resources	0.572	6
Reduce operational performance	0.564	7

#### **The factors contribute to integrated ISO 9001 and ISO 14001 systems**

Among the respondents, 80% of them agreed that top management is the primary factor constituting an IQS, followed by quality training (68%), cross functional communication (64%), supervisory leadership (64%). Education had the support of 52% of the respondents. The role of top management is to determine the firm’s vision, objectives, strategy, policy and long-term goals. They are in charge of managing employees and arranging resources for education and training. Thus, top management is the primary factor that constitutes to an IQS

and it is supported by most of the respondents. By conducting quality training and education, employees can improve their skills, enhance their commitment and thus perform their jobs better. Cross functional communication also plays an important role in an IQS. By breaking down barriers between departments, there is good communications between different departments. Thus, teamwork exists between different departments in order to achieve IQS. Supervisory leadership is as significant as cross functional communication for integrating ISO 9001 and ISO 14001. Supervisors are viewed as coaches by their employees to assist them in solving their unsure tasks.

On the other hand, 50% of the respondents agreed that product/service design is important for an IQS. Supplier management had the support of 50% of the respondents. The remaining factors are quality data & reporting (30%), quality policy (26%) and process management/ operating procedures (16%). The results show that these factors are not significant for an IQS and thus, these factors would not be analyzed in the second questionnaire survey. On the other hand, major factors chosen by the respondents would be proceeding with second order factor analysis in the following section.

## **8. FINDINGS OF QUESTIONNAIRE SURVEY - SET B**

The survey covered 34 companies which involved in various industries. The response rate was 17 percent, which was much lower than expected. The questionnaire was completed by the persons responsible for quality in the company who have firsthand knowledge of ISO implementation in these businesses. Among the respondents, 35.29 percent came from electrical and electronics industry, which is the largest industry sub-sector in Malaysia. There are 14.71%, 11.76%, 11.76% respondents came from plastic and rubber related, chemical based, equipment related industries respectively. Besides that, 8.82% out of 34 respondents were from furniture related, automotive related and food industries. The remaining 17.65% were from other industries.

All of the companies had obtained ISO 9000 certification. In terms of ISO 14000, 47% of the respondents had obtained it. Among the companies who did not obtain ISO 14000 certification (53%), almost all of them was following the recommended guideline to obtain this certification. These companies were aware of the important of ISO 14000 certification to their companies. In the area of integration, 9 companies were integrating ISO 9000 and ISO 14000. Among them, 2 companies integrated throughout the companies and the rest integrated in certain areas. This result indicates that current level of IQS implementation is not encouraging as many companies did not aware the benefits of IQS.

### *Second Order Factor Analysis*

The analysis results indicated that Factor 5 (Product/ service design) is the areas that in need of improvement. Product/ service design has positive effects on product/ service. Thus, companies should have their own research and development departments to design product/ service according to their customers' requirements. For Factor 5, two of the three variables comprising this construct had mean scores less than 3.00. It conveys that top management needs to use Quality Function Deployment (QFD) in product design as a communication tool to promote better understanding of customer demands and increasing customer satisfaction. Besides that, companies should break the barriers between various departments to involve every department in developing new product/ service.

On the other hand, the responding to the survey item "programs to broaden the employees' skills for future organizational needs" only 35% of the respondents ranked as "mostly significant" and "completely significant". This clearly indicates that top management need to invest on programs developing employees' skills in specific areas for future

organizational needs. Programs on effective communications play an important role as well. This is because the responding to survey item “programs to develop effective communications between employees” only 32% for “mostly significant” and “completely significant”.

### *Reliability*

There were 6 factors contributing an IQS and for each factor, there were a number of items to measure it. SPSS 15.0 was used to calculate reliability for the items of each factor separately. Table 3 shows the internal consistency analysis where the Cronbach’s alpha for different scales for IQS is listed. From Table 3, it is clear that the reliability coefficients ranged from 0.352 to 0.925, indicating that factors that having 0.352 and 0.363 were not reliable.

*Table 3 Internal consistency analysis*

<b>Factors</b>	<b>Number of Items</b>	<b>Cronbach’s Alpha</b>
1. Top Management	4	0.830
2. Quality Training & Education	5	0.925
3. Cross Functional Communications	4	0.874
4. Supervisory Leadership	5	0.830
5. Product/ service design	3	0.363
6. Process management/ operating procedures	3	0.352

## **9. DISCUSSION**

From the results of two sets of questionnaire surveys, it can be concluded that top management, quality training & education, cross functional communication and supervisory leadership are the primary factors constituting an IQS. The following paragraphs provide detailed explanations.

### *Top management*

Top management was indicated by the questionnaire surveys as important factor leading to an IQS (parameter estimation = 0.8,  $t$ -value = 3.65). Top management commitment is the first step for a company to implement IQS. They should first know what IQS by learning IQS. Top managers can learn from other organizations’ successful and unsuccessful experiences. Then, they can fit the specific conditions to their own organizations.

Top management should ensure that objectives for IQS are set in brief and clear way in order to direct the company with regard to quality improvement, continual improvement and prevention of pollution as well. IQS objectives should be based on integrated policy of the company to make it aligned. Besides that, top managers should be committed to ensure IQS comply with the requirements of ISO standards. They should strongly encourage their employees towards implementation of IQS.

In addition, top management must demonstrate positive attitude when employees face difficulties in learning and implementing IQS. They should trust employees can do things better and should be open to listen to the voices of employees as well.

### *Quality training & education*

The questionnaire surveys supported that quality training and education was the main factor for a company to step forward to IQS (parameter estimation = 0.93,  $t$ -value = 4.85). The main objective of training programs and education is to provide awareness for the need for and the benefits of an IQS. Besides that, how an IQS would be implemented and maintained should be included as the aim of training and education. It is important to ensure a clear

understanding of IQS requirements among employees. By understanding the system, it can eliminate employee resistance to the change. So, employees had the capacity to do their job better and thus their commitment can be enhanced. This factor supported the research findings by other researchers. Green [16] stated that if a company wants to be more competitive, it must strive to educate its workforce, from management levels down to integrate the concept of quality at all stages of production.

Training programs should be well designed by top managers. It should cover IQS, working discipline, special job skills, communication skills and team work development. IQS should be the focus of the training programs to ensure employees at all levels understand the principles, concepts and techniques of IQS. It is essential that all employees are trained in the new system and new procedures, especially in the initial phase before actual implementation. Employees will be more motivated if they have adequate understanding in IQS.

#### *Cross functional communication*

Cross functional communication is one of the factors constituting an IQS and it is supported by (parameter estimation = 0.63,  $t$ -value = 3.58). The success of IQS demands communication with and among all the organization members between different departments, suppliers and customers. By having effective communication across the organization as employees across different functions and levels using the same language, there would be improvement/opportunities associated with different departments. People from different departments can learn from each other and strong team work spirit can be built. This is more important for a process of product/service design where problems can be solved easily and compatible goals can be achieved together.

#### *Supervisory leadership*

Supervisory leadership was indicated by questionnaire surveys as one of the important factors for IQS (parameter estimation = 0.52,  $t$ -value = 2.53). For IQS to be successful in an organization, the supervisor must be committed in leading his employees in order to consistent with the aims of the organization. A supervisor must understand IQS and demonstrate their commitment through daily practices of IQS. Supervisors have to ensure that strategies, values and goals are transmitted down throughout the organization.

During initial implementation of IQS, employees might get confused and unsure with the tasks that they have to perform. Thus, they can seek their supervisors' assistance and view them as the coaches. By doing this, employees can reduce mistakes and thus increase opportunity for improving employee loyalty. It can lead to a successful IQS in the company.

## **10. CONCLUSION**

The primary objective of this study is to determine primary and secondary factors that constitute an IQS. An IQS framework is proposed for any manufacturing settings to initiate and implement IQS in their organizations. To carry out this research, the authors started by identifying factors of IQS presented in literature. The hypotheses were then tested among 50 respondents in an electronic company. The results highlighted the role of top management, quality training & education, supervisory leadership, cross functional communication, process/ product design and process management/ operating procedures. A second order factor model was then developed based on findings of first survey. For testing secondary factors, second questionnaire survey was then conducted among 34 companies in Malaysia. Second survey also focused on revealing current level of IQS implementation among the responding companies.



The results revealed that current level of IQS implementation is not encouraging. Many companies are not aware about this issue. In testing the reliability of second order factors of IQS, most of the factors had high *Cronbach's* alpha except process/product design and process management/ operating procedures. In principal component analysis, these two factors loaded more than one factor. Thus, they were rotated by varimax and quartimax. The *goodness-of-fit* index indicated that the proposed model moderately fits the data. The results can constitute a higher order factor that may be termed IQS. On the other hand, a framework of developing IQS has been designed to guide an organization to initiate and further implement IQS. An IQS map was developed in this study that is applicable in practice. It focused on the elements of ISO 9001 and ISO 14001 that can be integrated.

Prior to conduct further research, it is important for the researcher(s) to overcome shortcoming of this research. Firstly, it is important to know how effectiveness of the proposed framework of IQS and IQS map for the organization. Further studies can focus on addressing how an IQS influence the company's performance. This will be meaningful if one can understand the contribution of IQS towards the involvement of all levels of employees in the organization. Besides, researcher should work closely, preferably with the SMEs companies to monitor the changing needs and problems faced during initiating and implementation of IQS.

Secondly, further research can focus on determining the performances of different outputs of the companies. For instance, goal programming can be used for measuring multi objectives performance of a company. Also, software development is important in handling the data such as MRP II or ERP. Finally, it should be emphasized that a continuous study from time to time will help a lot. It may help the researcher to gain in-depth understanding of IQS that will prove beneficial to the SMEs in long term.

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